Available online at www.sciencedirect.com
SciVerse ScienceDirect
IERI Procedia 2 (2012) 715 – 720
Procedia IERI
www.elsevier.com/locate/procedia

2012 International Conference on Future Computer Supported Education

Development of the Electronic Engineering Case Library--Classroom Response System

Zhuozheng Wang*, Quanying Zheng, Junhua Liu, Yan Lv, Tingting Bian

Pilot College of Beijing University of Technology, Beijing 100124, China

Abstract

In order to train excellent engineers for industrial, Electronic Engineering Division of Beijing University of Technology attempts to establish a professional case library. The development and implement of the case library stimulate enterprises involved deeply. This paper presents one typical case called Classroom Response System(CRS). The design of CRS, touch screen display and wireless transceiver module are described, which offers useful teaching materials and improves students' ability of engineering practice and teamwork spirit. In addition, enterprises can easily upgrade this case for the product. Case library provides a new approach to develop university-enterprise win-win strategy.

Keywords: Case library, Classroom Response System (CRS), Zigbee, university-enterprise win-win

1. Introduction

In the past five years, as one of the key division in Beijing University of Technology which is in the Chinese Education Ministry's top 100 211-Projects universities, Electronic Engineering Division struggled and pushed out the advantages. Finally, it has been permitted in Excellent Engineers Plan by Chinese Education Ministry in June, 2011.

* Corresponding author. Zhuozheng Wang Tel.:+86-010-52334036; fax: +86-010-52334037.
E-mail address: wangzhuozheng@bjut.edu.cn.

 doi:10.1016/j.ieri.2012.06.159

As the experimental field of Engineering High Education, the most characteristics of this division is depth cooperation with industrial. Electronic Engineering is one of the fastest developing IT field. It consists of Signal Processing, and Circuits and Systems, and software and hardware development comprehensively. In the fact of bringing up the ability of engineering practical ability, original experiments and curriculum designs can't meet the requirements of engineering high education, and can't bring the fresh experience of software and hardware development, especially in teamwork spirit. Therefore, the division develop 'Case Library' with IT enterprise based on the research on hundreds of universities, which can improve the training in the comprehensive abilities of an excellent engineering.

Case Library, is some like the real project in industrial but modified to adapt teaching. The main features of cases are,

1) Cases are stripped from the real developed project or improved from the developing project.
2) The case has two hands with certain forward-looking. One is that it will be optimized to upgrade a new product flexibly, The other is that the case contains rich professional knowledge, in terms of size or difficulty facts, it will meet the teaching needs to build a professional knowledge system;
3) Cases have the scalable and updated features. Develop the cases to modules by using Object-Oriented thinking. These modules can combine by free. It will be more flexible.

The cases are stemmed from projects. The operators of these cases are senior engineering, excellent teachers, professors, and students. The establishment of the case library not only can serve for universities to provide a rich learning platform for teachers and students, but also for enterprises to cultivate talents, even become the product developing center. Case Library itself is a product as auxiliary product applications in the study of higher education. It provides a clear practical main line for the cultivation of excellent engineers which will make university-enterprise cooperation reach win-win situation. This paper describes one of the Case Library, which is Classroom Response System(CRS), try a new engineering education and training model for high education.

2. The composition of the Case Library

According to the characteristics of case library, it is mainly composed of four parts. They are the hardware modules, software code library, project documentation, and teaching documentation, which are shown in Figure 1.

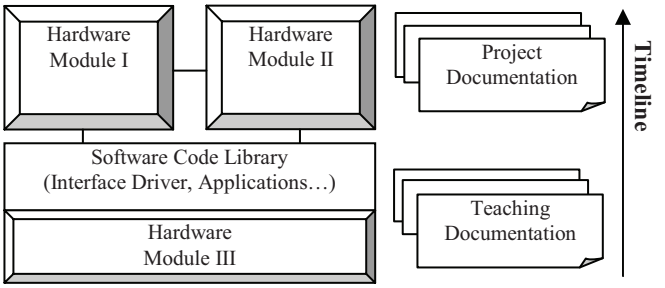

Fig. 1. Composition of case library

Hardware modules are the main body of the case library; Software code library contains source code, interface driver, applications and comments. As is well known that, there is no standard answer in the software source code. Different programmers have the different coding styles and answers, but the result is same. Therefore, the code library will store several developed and improved versions by different developers

and students. It is necessary to use a version control mechanism, named 'snapshots', in this project. 'Snapshots' is composed of implicit timestamp, categories of developers, and purposes of development.

Project documentation includes project management documents, role design documents, hardware design schematics, hardware and software summary and detailed design documents, test document, project illustrations etc.,

Teaching documentation is composed of the experimental instructions and how to implement with rules some like law in case library. The experimental instructions similar to the previous experimental guide books in class lab or curriculum design. In addition to the subject content body, purposes, requirements, and results, the definition of project parts, role assignments, score criteria, references and hardware platform description will be explained in detail. Software codes and hardware schematics and simulation results will be stored by separated directories with version control identifier.

3. Classroom Response System

3.1. Overview

With the rapid development of multimedia technology, classroom response system came into being. According to statistics, there are almost 50 brands classroom response systems(CRS) in China, even their functions are very much the same. Usually, classroom response system has four main functions. Firstly, it has classroom evaluation functions to judge students' performance in the class. Secondly, Interaction drives teachers and students to emerge into participating discussion. Thirdly, records and statistics make teaching process fair and transparent. Finally, wireless computer management benefits teachers to manage students easier.

CRS mainly contains Receiver, Terminal Stick, and Application Software. Everyone click his selection by using terminal stick in the class. Due to wireless transmission protocol, the signals are received and processed by Receiver. At last, application displays the user-defined format of the results, such as line graph or histogram chart. Through this system, the terminal holder can judge the answer. The speaker can watch each person's selection, and can interpret the graph. Interactive method can increase the fun of the classroom, as well as the students' sense of accomplishment, increase interest in learning.

One of the most popular CRS products is called '*i>clicker*' from Macmillan in USA. It stems from the invention in the garage by three professors of University of Illinois, Tim Stelzer, Mats Selen, Gary Gladding, and Benny Brown. The prototype has now developed into covering the whole of North America (U.S., Canada), the leading technology platform for the benefit of more than 2 million students. Its 'stable', 'intuitive' and 'fast response' are well known. Professor Edna Ross of University of Louisville evaluated this product as 'easy to learn, easy to use, totally reliable and dependable, and a wonderful tool for engaging students.' Meanwhile, the customers of the product involved in higher education, k-12 education, government and nonprofit organizations.

3.2. The design of CRS

The hardware system is divided into the Terminal, the Receiver and Display. Teachers design a topic and send the demand to start by clicking Terminal 1 (adv. T_1); Students think the question and select their choices by clicking T_n; when Receiver gets the signals from students it will make special chart and analysis, then display the results for teachers and students and response the signals to all terminals. Signal flow graph is shown in Figure 2.

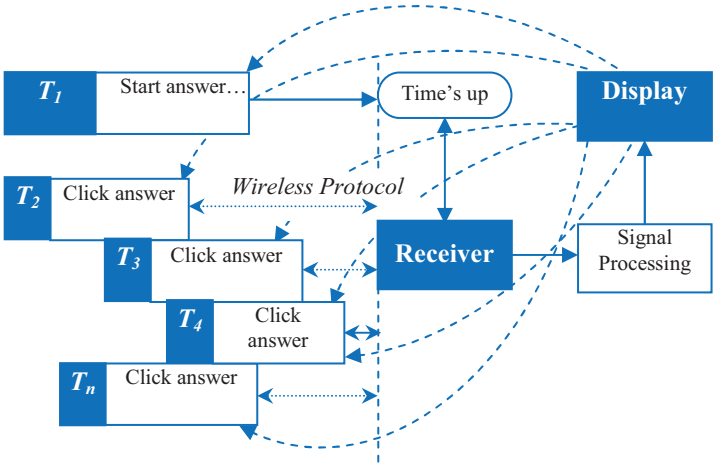

Fig. 2. CRS Flow Chart

The hardware compositions of terminal are processor, wireless transceiver modules, buttons, display and power supply. ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802.15.4 for personal area networks. Applications include wireless light switches, electrical meters with in-home-displays, and other consumer and industrial equipment that require short-range wireless transfer of data at relatively low rates. Data transmission rates vary from 20 to 900 kilobits/second. In this project, 2.4GHz frequency is used to transmit the signals. Buttons contains the keys of 'option selection', 'power', 'cancel', 'previous/next page', 'direction: up/down/left/right' and laser point. Display is composed of touch screen, control circuits and ports.

3.3. Touch-screen display

The core of touch-screen display is touch screen control chip. In this project, TSC2046 from TI is used to communicate with DSP processor, namely OMAP3530 from TI. Driver follows the standard SPI communication protocol. When a touch screen event occurs, the touch screen controller TSC2046 send interrupt requests to DSP processor through interrupt pins (TSINT). After processor received the requests, processor delays 30ms, and then responses which can eliminate jitter to make sampling more accurate. If one time sample is not accurate, multiple sampling is required to take the last result.

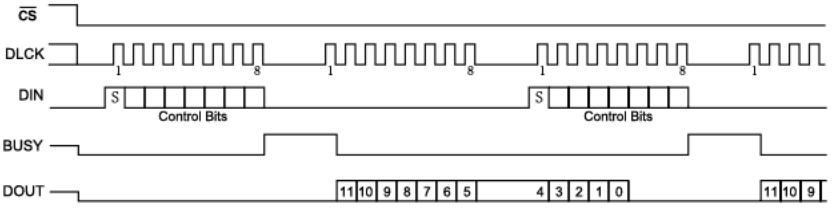

Fig. 3. Sequence Diagram in Touch Screen Processor

When TSC2046 received the 8 bits measurement instruction, it will take period of time to complete the measurement and A/D conversion. Therefore, *BUSY* signal will output high voltage on the rising edge of step

signal. It will not output data until the falling edge of step signal (Figure 3). During this period, chip-select signal called $\overline{CS}$ remains valid. In the pass 8-bit instruction transmission, processor maintains the valid status of $\overline{CS}$ and clock($DCLK$) to receive the measurement results and data. The 12-bit signal of transmission is presented by $DOUT$. It should be noted that, 16-clock signal can meet A/D conversion once. To get the correct A/D conversion results, $DOUT$ should add up 4-bit free clock signal and its original 12-bit data. Otherwise, TSC2046 with OMAP3530 processor can't be synchronized which will lead into no data output.

In addition, to avoid signal interference with the digital signal to analog voltage, the processor stops SPI communication until the end of the A/D conversion after sending the TSC2046 Control-Word(CW).

3.4. Zigbee wireless Transceiver Module

This module highly integrates IEEE 802.15.4 standard 2.4 GHz *RF* transceiver. There are a few peripheral circuits to complete wireless signal transmission. While in sleep mode, it takes only 0.9μA of electric current consumption, external interrupt or RTC can wake up the system; in standby mode, it takes less than 0.6μA of electric current consumption, the external interrupt can wake the system.

Table 1. Transfer data protocol format

Identifier	ClassID	UserID	Answer	Seconds	Status	Remains
Number of bits	3 bits	8 bits	3 bits	1 byte	2 bits	3 bits

In this case, Z-Stack solution suite is used as ZigBee compliant protocol stack for an expandable CRS. Based on this protocol stack, Receiver abides the rules (Table 1) to identify the response signals and analysis.

'*ClassID*' has 3 bits digitals to present which class to communicate with; '*UserID*' presents student's number by 8 bits digitals; Students click the '*Answer*' composed of 3 bits binary numbers; '*Seconds*' records the thinking period seconds; '*Status*' is used to indicate success, waiting, and failure the three feedback states. '*Remains*' is used to extend in the future.

Classroom Response System is a regular integrated system. Only one course is not sufficient to complete the entire system from requirements analysis, design, implementation, to the final test. Therefore, this case can be divided into multiple modules to develop and teach across multiple semesters and several stages.

In this case, the partition of semesters and modules are: in the third semester, low power supply; in the fourth semester, processor and keyboard driver; in the fifth semester, touch screen display and system software development; in the sixth semester, wireless transceiver module; in the seventh semester, application software development and testing.

4. Summary and Outlook

This case achieves the development of CRS. By using this system, Teachers can understand the students' ability to comprehend and the students' understanding of the knowledge in real time. It provides useful evaluation of classroom effectiveness and reference data for the teacher's teaching and research. This case itself is not only a teaching and research auxiliary product, but also the process of development is an academic comprehensive practice courses across multiple semesters.

Practice has proved that CRS is an effective teaching research and ancillary product. This paper presents some new features to be used in the future upgrade. For the needs of long time power supply, changing battery troublesome and environmental protection, power supply system for the terminals can be upgraded to the solar low-power supply system; In addition, the students four years of study and performance information

can be recorded in the processor, which is similar to the file, then it will be the next generation of student ID card in the future.

In summary, this case can be improved to upgrade a product by engineers. Furthermore, the development of the product itself is a learning process. The participation of teachers and students can stimulate their interest and improve students' engineering practice ability and teamwork spirit. For teachers, it can enhance teachers' ability to decomposing knowledge and engineering background. The development and implementation of the case library can effectively complement requirement of 'enterprise deeply involving' in the Excellent Engineers Plan. This paper provides the solution to integration of production education and research to develop university-enterprise win-win strategy.

Acknowledgements

The authors would like to thank CEO Yue Zhang of CMI and General Manager Yong Wu of EFLAGTECH. They give precious proposals to Excellent Engineers Plan. The research work is supported by General Program of Science and Technology Development Project of Beijing Municipal Education Commission of China (Grant No. KM201110005033).

References

[1] Paolo Baronti, Prashant Pillai, Vince W.C. Chook. Wireless sensor networks: A survey on the state of the art and the 802.15.4 and ZigBee standards. Computer Communications 2007; 7(30):1655-1695.
[2] Baker, N. ZigBee and Bluetooth strengths and weaknesses for industrial applications. Computing & Control Engineering Journal 2005; 2(16):20-25.
[3] Wheeler, A. Commercial Applications of Wireless Sensor Networks Using ZigBee. Communications Magazine, IEEE 2007; 4(45):70-77.
[4] Conceição Vedovello. Firms' R&D Activity and Intensity and the University–Enterprise Partnerships. Technological Forecasting and Social Change 1998; 3(58):215-226.
[5] S Marginson. The enterprise university: Power, governance, and reinvention in Australia. New York: Cambridge University Press; 2000.
[6] Elkington, J. Towards the sustainable corporation: Win-win-win business strategies for sustainable development. California Management Review 1994; 2(36):90.
[7] Kartik Kalaignanam, Venkatesh Shankar, Rajan Varadarajan. Asymmetric New Product Development Alliances: Win-Win or Win-Lose Partnerships. Management Science 2007; 3(53):357-374.
[8] Prigge, George W. University-industry partnerships: what do they mean to universities? A review of the literature. Industry and Higher Education 2005; 3(29):221-229.